

# National Pharmaceutical Stockpile Drill Analysis Using XML Data collection On Wireless Java Phones

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**Abstract:** *This study describes an informatics effort to track subjects through a National Pharmaceutical Stockpile (NPS) distribution drill. The drill took place in Seattle on 1/24/2002. Washington and the State Department of Health are among the first in the nation to stage a NPS drill testing the distribution of medications to mock patients, thereby testing the treatment capacity of the plan given a post-anthrax exposure scenario. The goal of the Public Health Informatics Group at the University of Washington ([www.phig.washington.edu](http://www.phig.washington.edu)) was to use informatics approaches to monitor subject numbers and elapsed time. This study compares accuracy of time measurements using a mobile phone Java application to traditional paper recording in a live drill of the NPS. Pearson correlation = 1.0 in 2 of 3 stations. Differences in last station measurements can be explained by delay in recording of the exit time. We discuss development of the application itself and lessons learned. (MeSH Bioterrorism, Informatics, Public Health)*

**Keywords:** Disaster response, Point-of-care systems, Technology assessment

## Introduction

Public Health Informatics faces many challenges as the nation prepares for the threat of bioterrorism. Treating the public in the wake of a biological attack has all of the challenges of normal clinical care with the added requirements that large numbers of people must be quickly treated, and that the distribution of medications be undertaken in sites with little or no existing infrastructure. The CDC has developed the National Pharmaceutical Stockpile <sup>1,2</sup> to permit large quantities of antibiotics to be delivered within 12 hours anywhere in the USA. The CDC has placed the development of a distribution plan into the hands of the State Health Departments. With the exception of the NPS uses following actual anthrax exposures <sup>3</sup>, Washington State is the first state to carry out a drill of a NPS plan <sup>4</sup>, held at the University of Washington (UW) on January 24, 2002 <sup>5</sup>

Plans to test Washington State's capacity to distribute a NPS "push-pack" had been in the works since Spring 2001, but the original test date was delayed by the events surrounding September 11. .

The Public Health Informatics Group of the University of Washington assisted the State Department of Health in coordinating the informatics components of the drill. This paper describes one of these components, the use of mobile phones running a Java 2 Micro Edition (J2ME) <sup>6</sup> data collection application that we developed to track subjects as they moved through the drill. We hope that our approach and the methodologies for live patient tracking described in this paper will help other states to test the capabilities of their NPS distribution plans.

## Planning and Preparation

Preparing for the Department of Health's (DOH) Washington State stockpile plan <sup>4</sup> involved multiple agencies and departments including the Public Health- Seattle and King County, Seattle City Fire Department, University of Washington Police Department, and representatives from many schools and academic departments at the UW. The Public Health Informatics Group was invited to assist with coordinating IT for the simulation. Planning meetings took place during the three months leading up to the event. During these meetings research questions were posed, for example: 1) how long will the average test patient take to complete the process from entry to exit?; 2) what is the maximum capacity to dispense medications given a number of staff?

## Informatics Enabled Intervention

To eliminate the need for extra personnel to perform data collection for a time/motion study, we proposed developing an application that could be used in a non-intrusive fashion to record the time that each subject reached each station. Data collected at entry and exit could be compared to the paper record of entry and exit time.

To give the Department of Health a more granular view of time spent per station, we proposed taking the measurement of time the subject took to get from station to station as well as the total time. A paper system could have been used at each station to track patients as well, but several benefits could be accomplished by testing this new informatics approach as a mass disaster management tool.

Java capable phones can store data locally, then forward it to a web-based server for immediate analysis. There is minimal delay in data entry to the database as each phone has network access and can upload the collected data periodically during the exercise. This could give public health officials near real-time information about the number of patients that had been treated at a given distribution site. When compared to available quantities of medications the need for redistribution of medication could be recognized before inventory was depleted. Public health officials could also remotely recognize occurrence of long delays and the need to increase staffing of health screeners and pharmacists/med technicians.

## Methods

### Subjects

The UW was selected as the drill location and distribution point for this area. Over 250 UW faculty, staff, and students volunteered to participate in this event as test subjects. Volunteers were recruited using an email and web page sign up process (<http://phig.washington.edu/NPS>). Also attending the drill were 85 national and state observers, some of who also participated as test subjects.

### Setting

There were six discrete points or stations in the drill: (a) pre-drill station: volunteer registration; (b) triage area at start of drill: welcome/greeter, health assessment and educational station; (c) registration, clinical history station; (d) pharmacy drug dispensing station; (e) exit and feedback evaluation station; and (f) early exit station: for subjects deemed ineligible to receive medication. Stations c and d, which were more time intensive, had 3 and 4 separate tables, respectively, for distributing the load. Other stations (a, b, e, and f) consisted of only one table. Two to five public health workers staffed each table.

### Data Collection

Start and exit times were collected via a traditional paper system and later entered into a spreadsheet for analysis. Two separate elapsed time measures, total time for drill (station B to E) and total time for simulation (including pre-drill registration, station A to E), were taken. In addition to this, at each station public health workers, with only a brief orientation to the data entry task, used the Java application running on mobile phones to enter the subject's record number as they reached the station. These time points for start and exit time as well as more points along the drill were collected and wirelessly transmitted to the database using the phones.

## Application specifications and development

We developed specifications for Java application using the J2ME on Nextel i90c and i85 phones. The users select the location or station that they are working at and then enter the subject data collection screen. Here they simply enter in 4 digit IDs for each person who passes that location, and then press "submit". The phone will save the ID, location, and timestamp, and is immediately ready for another subject ID.

At the end of the day, or intermittently during the drill, the person with the phone has the ability to "Upload Data" from the phone to a web server. When the user selects this option from the main menu, they are prompted for a URL, which defaults to the NPS project site. The data is uploaded to that URL in XML format and deleted from the phone. The XML file includes the Subject ID number, time stamp in milliseconds and the station location (see figure 1).

The contents of the HTTP POST include the headers:

- 1)"If-Modified-Since" with a value of "29 Oct 1999 19:43:31 GMT"
- 2)"User-Agent" with a value of "Profile/MIDP-1.0 Configuration/CLDC-1.0"
- 3)"Content-Language" with a value of "en-US"
- 4)"Content-Length" with a value based on the length of the body of the URL.
- 5) String of XML data (see figure 1)

**Figure 1: XML record**

```
<time_motion_record>
  <subject_id> 0001 </subject_id>
  <location>A</location>
  <timestamp> 1011291544474</timestamp>
</time_motion_record>
<time_motion_record>
  <subject_id>2236</subject_id>
  <location>A</location>
  <timestamp>1011296567257</timestamp>
</time_motion_record>
<time_motion_record>
  <subject_id>2222</subject_id>
  <location>A</location>
  <timestamp>1011295745010</timestamp>
</time_motion_record>
```

*...with additional xml tags for every record.*

An alternative xml structure with the milliseconds <timestamp> divided into equivalent <time> and <date> was also considered.

Once the XML data has been uploaded to the web server it was imported into our Microsoft SQL Server database using an automated XML bulk load application. Data was still in entity, location, value format. Individual records were then converted to one row per subject ID with times for each station for analysis.

For this trial we did all of the data analysis after completion of the event and using manual techniques to calculate time intervals (this was a simple matter of subtracting one point from another, as data was stored as milliseconds).

### Data Analysis

Times collected by paper and electronic means were compiled and statistics such as mean, median, and standard deviation for each set were calculated. To test for statistical difference between the two methods a paired t-test with statistical significance set at 0.05, and a Pearson correlation were performed. The time elapsed between stations that did not have a paper measure, which is of great interest in the operational planning of NPS distribution, can be calculated from the electronic data.

## Results

We excluded 38 records which had duplicate entries for the same subject ID at the same station at different times from analysis, because we had no way to determine which time, if any, was correct.

One unanticipated error was that two of the phones transmitted correct times, day, and month, but years that were 2001 and 2003 respectively. This slowed data analysis since we had to correct times entered from those phones (by adding or subtracting integral numbers of years in milliseconds) in order to proceed.

Statistical analysis was then performed on those sets for which we had complete records and were compared to data collected by the paper record.

207 participant records were obtained for both the paper and phone. Comparative average times are shown in Table 1, below.

**Table 1:**

	Phone XML recorded Time	Paper Recorded Time
Station A to E	44.51	41.19
Station B to E	35.1	31.82

### t-Test: Results

#### (Time elapsed between stations A and E)

The results of an paired t-test:  $t = -1.64$  sdev= 20.6  
The probability of this result, assuming the null hypothesis, is 0.10

**Paper Record:** Number of items= 207

(Time from station A to end of station D)

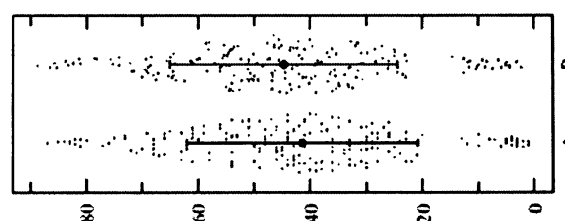
Mean = 41.2 95% confidence interval for Mean:  
38.38 thru 44.01 Standard Deviation = 20.7

**Phone Record:** Number of items= 207

(Time from station A to station E)

Mean = 44.5 95% confidence interval for Mean:  
41.69 thru 47.32 Standard Deviation = 20.4

**Figure 2: Paper vs. Phone  
histogram elapsed between stations A and E**



Time (in min) Paper (A) vs. Phone(B) Methods

### t-Test: Results

#### (Time elapsed between stations B and E)

The results of an paired t-test:  $t = -2.05$  sdev= 15.4  
The probability of this result, assuming the null hypothesis, is 0.041

**Paper Record:** Number of items= 204

(Time from station B to end of station D)

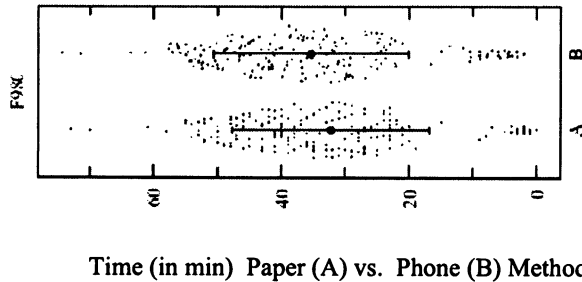
Mean = 32.3 95% CI for Mean: 30.16 thru 34.39  
Standard Deviation = 15.5

**Phone Record:** Number of items= 204

(Time from station A to station E)

Mean = 35.4 95% confidence interval for Mean:  
33.28 thru 37.51 Standard Deviation = 15.3

**Figure 3: Paper vs. Phone  
elapsed time between stations B and E**



**Difference in time at each of the 3 data points.  
Paper vs. Phone**

For those data where we had matched phone and paper records, we calculated the differences between the two. Note some difference is expected as paper records only record times to the nearest minute, while the phones recorded time stamp to within 1 millisecond. For the purposes of this study all times were truncated to the nearest second.

**Station A:** The paper-recorded time is, on average, five seconds later than that from phone data ( $n=154$ ). After removing five improbable data points that were an order of magnitude off the mean phone time is 27.5 seconds (range 85s to -69s) later than that of the paper-record ( $n=150$ ). Differences between times at Station A are not significant. Pearson correlation = 1.00

**Station B:** The phone-recorded time is, on average, 72 seconds later than that of the paper-record ( $n=176$ ). After removing improbable values in one case (4999s), the phone data give times that are an average of 45 seconds (range 104 to -27) later than that of the paper-record. ( $n=175$ ) Differences between times at Station B are not significant. Pearson correlation = 1.00

**Station E:** The phone data give times an average of 227 seconds later than paper records ( $n=176$ ). After removing five improbable negative values the average is 187 (range 32 to 500s) seconds later than that of the paper record ( $n=171$ ).

### Discussion

Time differences for total time at stations are explained by a combination of: 1) rounding error (phones recorded millisecond-resolution times but paper records only indicate nearest minute.); 2) paper

exit time was recorded as they left station D from one of 4 tables, but phone exit times are approximate, based on subjects reaching the exit survey table (Station E); 3) Station E was overwhelmed. The operator typically had to back enter data on the phone as multiple people would leave at the same time, and since there was only one phone at this station the phone's memory capacity was exceeded thus slowing the applications performance. The average delay at station E of 187 seconds (or more than 3 min) for the exit time accounts for the discrepancy between total average simulation time between paper and phone records. Thus this was not as good of a proxy for exit as we had hoped. Despite all this it is interesting that average total times from Station B to E were not statistically significant, (0.04), however the measurement of total time from station A to E had a p value of 0.10, indicating that improvements could be made in logistics of how the time analysis is done using this new approach.

### Data Discrepancies and Lessons Learned:

One can never have too many phones. We tried to over-estimate the number of phones needed, but still did not have enough to electronically record both start and exit time from station D (the pharmaceutical dispensing station). Therefore, we had to use station E as a proxy for the completion of the drill.

We had checked that all phones had the right day and time. In future versions the application should display year, not just month and day. One cannot assume the phones have been set up properly.

One interesting fact was there was electronic evidence of some records that were not in paper-recorded data. There was no matched paper form. One hypothesis to explain this is that some of the paper forms were not turned in by the volunteers. This casts doubt on the use of the paper-recorded times as the gold standard.

We had 38 cases where the same ID numbers were used multiple times. This could have been user error (i.e. mistyped ID) on the part of personnel entering numbers into the phones or some of the forms (numbers) may have been mistakenly reused or recycled. Less probably, subjects could have been secretly going through the line more than once, perhaps to get extra candy. This made analysis more difficult as these records cannot be reconstructed into correct sequences by our existing process and must be looked at by hand. This emphasizes the need for either a robust ID number, perhaps with a check digit, or a second ID such as social security number, or phone number, which could be cross checked against

the first, were this system to be used as a primary data collection system for NPS distribution.

Another difficulty was that 5 of the phones did not upload data successfully; this was secondary to a data length limitation per transmission. We had tested 20 – 30 record transmissions, but had not tried >100. This exceeded the phone's available RAM and we had not built in the capability to segregate the record. We have since corrected the beta application to allow for this, and retrieved those records from all but one of the phones.

The J2ME environment does not inherently know how to handle an authentication request from an HTTPS (SSL) server. We plan to redesign the application to prompt the user for a login and password when the authentication request arrives, but this version of the application uploaded unencrypted, anonymous data to a server that did not require authentication. We felt this was a reasonable tradeoff. It allowed us to develop and deploy rapidly in the phone platform, especially in light of the fact that this was only a simulation, and the four digit identifiers would only have meaning to those with access to the paper records of the drill.

Future capabilities should also include the ability to record what medication the patient was given (this could be done as a short pick list as the contents of the push packs would be known and the ability for demographic information about the patients to be uploaded directly into the phone using a keyboard (or at least a field to record the zip code and phone number of the patient could be done for GIS tracking and follow up). This would not have been an option in the simulation, as Human Subjects/IRB did not cover us collecting any real information about the volunteer's identities

In an actual event public health officials would want to fully automate the data analysis as a near-real-time view of the process.

### Conclusions

This study showed that a java phone application could be used to record time and location of subjects in a drill of the NPS. This technology was inherently deployable and portable. Minimal orientation to new hardware was needed since everyone was comfortable with entering numbers on a phone keypad and pushing the send button. Accuracy was aided by avoiding the need to synchronize watches, as times are transmitted from a common cell tower. Although some statistically significant differences were noted, we feel the logistical issues and staffing of the exit station were the source of the error and not the application or database. This was an overall success and

we can learn from the flaws and stresses that a live trial of a beta application provides.

We hope to have the opportunity to perfect this application and its use in disaster response and public health informatics.

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